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CHEMICAL & ENGINEERING

NEWS

1986 ACS Annual Report Page 33
Scientific news from the Denver ACS meeting

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Adhesive Monomers

Higher demand raises supply concerns

A Key Chemicals Review
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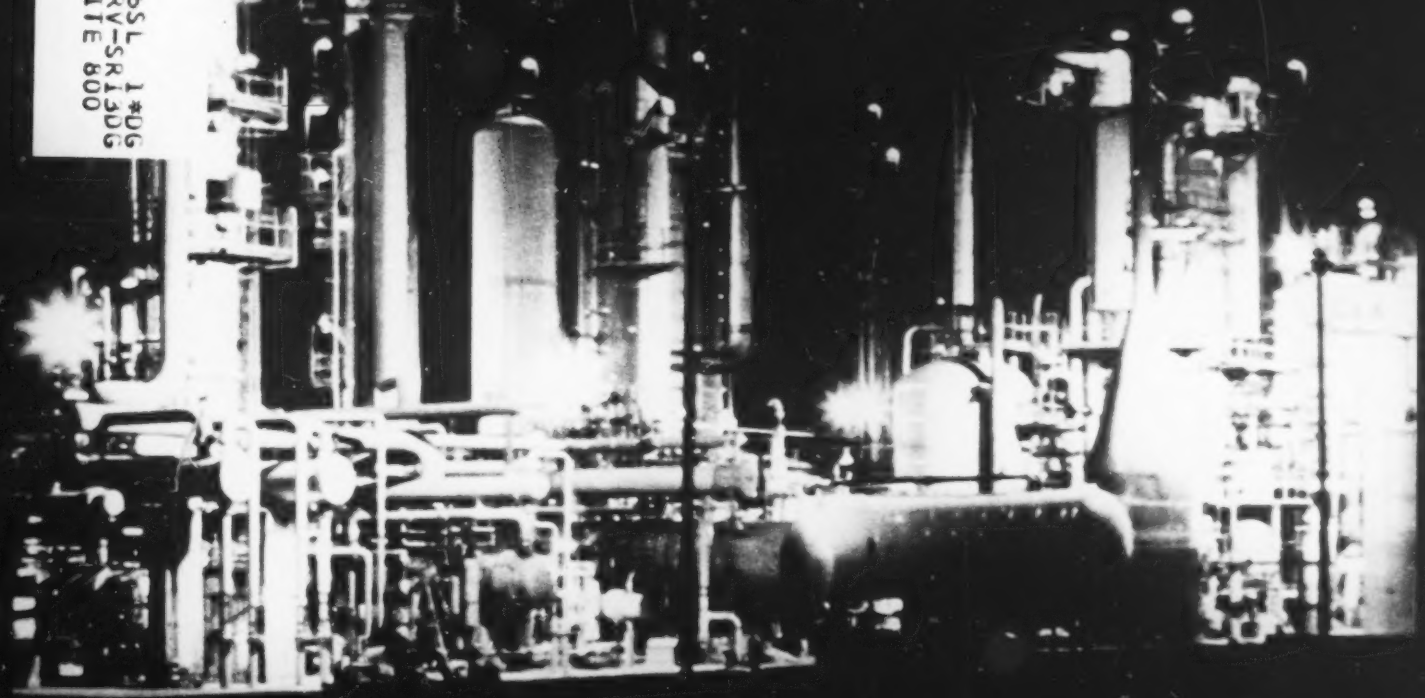

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NEWS

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APRIL 20, 1987

News of the Week

■ **Merrill Lynch agrees to acquire Borg-Warner in leveraged buyout.** **Page 4**

■ **Independent research at two labs yields information on structure of new AIDS virus and mode of action of AIDS virus on human cells.** **Page 5**

■ **Texaco continues daily operations after filing for bankruptcy under Chapter 11.** **Page 6**

■ **Complaints about preshipment inspection companies are aired at an International Trade Commission hearing.** **Page 6**

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ACS Denver symposium examines tax reform, with its lower rates and more complex features. **Page 14**

Federal support for science is high, but scientists at AAAS symposium are concerned about how research funds will be divvied. **Page 16**

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ACS Annual Report

Adoption of revised mission statement, initiation of plans for National Chemistry Day, and expanded involvement in public affairs highlight ACS in 1986. **Page 33**

Education

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ACS News

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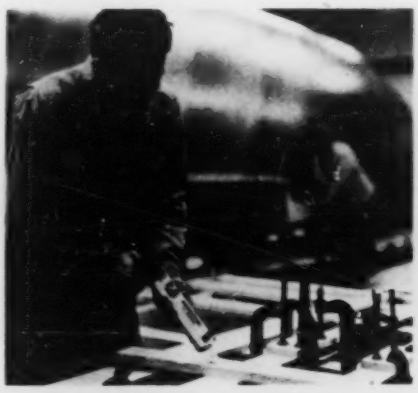


Business

The increase in demand for major adhesive monomers formaldehyde, phenol, and vinyl acetate and high plant operating rates are raising the prospect of supply shortages. **Page 9**

Supply Problems Loom for Big-Volume Adhesive Monomers

Increasing demand for phenol, vinyl acetate, and formaldehyde, coupled with high plant operating rates, raises specter of shortages

Bruce F. Greek, C&EN Houston

Concern is growing over the possibility of shortages in the supply of major adhesive monomers. Capacity utilization of plants producing two of them—phenol and vinyl acetate—is now nearing the effective limit. Plants making the other intermediate, formaldehyde, still have a low utilization rate, but that situation could change quickly if demand continues to rise and plant shutdowns cut capacity drastically.

Additions to capacity to make these materials, other than minor debottlenecking, if initiated now, will not be available until near the end of the decade. There have been no recent announcements or rumors of sizable additions, even as capacity utilization has risen. Producers have considered expansions unjustified in view of the low prices they have been receiving. Although prices have risen and are rising, they still are below levels allowing an adequate return on investment, especially in competition with depreciated plants.

Prices could continue to increase, as supplies of these materials tighten. Fortunately, such increases could help the supply situation for phenol and vinyl acetate by curtailing exports. Price increases likely will dampen U.S. demand for these materials in end uses where their cost/performance qualities are only marginally better than for other materials. Prices of exports usually are below U.S. prices, and export prices could be kept down in the future by competition from new plants being built outside the U.S. Such price incentives could shift supplies to the U.S. market.

Key Chemicals

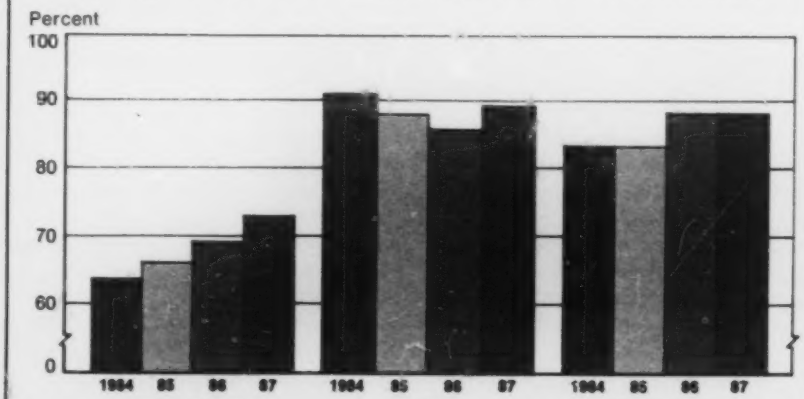
A decrease in exports of both phenol and vinyl acetate can provide a substitute for capacity expansions to meet U.S. demand for these monomers. Because more than a quarter of vinyl acetate production is exported, it has the largest cushion of material available to supply U.S. consumers. Exports of phenol, although increasing, are much smaller, but are equivalent to some two to three years of recent demand growth in the U.S. Very little formaldehyde is exported; most of it is handled as solutions and it is too costly to ship as solutions to export markets.

If prices and demand for the monomers in the U.S. keep rising, a shift from substantial exports to some imports eventually could occur, although that doesn't seem likely in this decade. World demand for these adhesive materials also continues to rise, and in many places faster than in the U.S. The increased demand is absorbing the new capacity being built in such areas as Japan, South Korea, and Taiwan.

Higher prices for the major adhesive materials will have little effect on U.S. demand. In most adhesive applications, no acceptable substitutes exist that provide the necessary properties. However, in other, smaller uses, some materials could replace the monomers. For example, demand for various textile sizes made using polyvinyl alcohol from vinyl acetate could decline significantly if imports of apparel continue to rise in spite of various efforts to curb those imports.

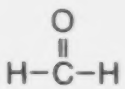
For details of the near-term outlook for these adhesive materials, please see the following pages.

Operating rates rise for most major adhesive monomers



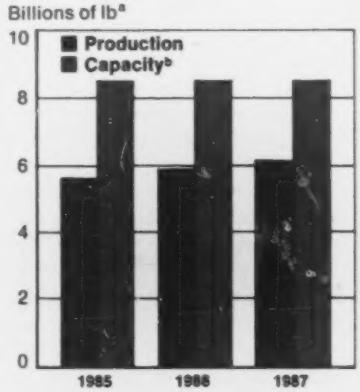
a Synthetic only. Source: C&EN estimates

Formaldehyde



- *Output rising slowly*
- *Capacity on hold*
- *Prices firming*

PRODUCTION/CAPACITY



a As a 37% solution. b First quarter, some capacity may not be operable but not yet scrapped.

MAJOR PRODUCERS

Borden, Celanese, Du Pont, Georgia-Pacific, Monsanto

HOW MADE

Catalytic oxidation of methanol

MAJOR DERIVATIVES

Urea-formaldehyde resins 30%, phenol-formaldehyde resins 25%, acetylenic chemicals (mostly 1,3-butanediol) 5%, polyacetal resins 5%

MAJOR END USES

Adhesives 65%, plastics 15%

FOREIGN TRADE

Exports and imports small, each about 10 million lb per year

PRICE

About 19 cents per lb, list, at merchant producer plants on Gulf Coast

Formaldehyde production will increase in 1987. However, growth will be slower than last year if housing demand holds at current levels. Capacity is more than adequate and will remain so, even though ownership of a few plants is changing and some units are being shut down. Because prices of methanol—the raw material for formaldehyde—have recovered, the relatively small merchant market is strengthening.

Housing generally accounts for about two thirds of U.S. formaldehyde consumption. If housing demand roughly equals last year's, then output of formaldehyde will expand more than 4%, or 300 million lb as 37% solution. (Other concentrations of solutions are available in the merchant market, including a solid form, but traditionally the industry reports production in terms of the 37% solution.) Housing plus additional demand for other uses could boost output to more than 6.2 billion lb as 37% solution. At that level, however, production still would match roughly that of 1978 and 1979 and would be below 1973's output of more than 6.4 billion lb.

If housing starts decline as much as the 10% forecast by less optimistic views of this market, formaldehyde output then will be flat or up less than 1% to amount to 5.9 billion to 6.0 billion lb. The preliminary estimate for 1986 production by the U.S. International Trade Commission is 5.89 billion lb, up from 5.61 billion lb in 1985 and largely because of strong housing demand.

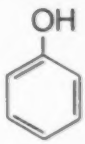
U.S. nameplate capacity for formaldehyde is about 8.5 billion lb as 37% solution. Because demand for derivatives used as adhesives varies seasonally, not all of the units are operated at any one time. Some that make formaldehyde for captive use are located at or near consumption sites—such as plywood manufacturing plants—and have relatively small capacities. On the average, however, formaldehyde capacity will be operated at close to 72% of nameplate this year, slightly higher than in the two preceding years. More smaller units are expected to be shut down because of current excess capacity.

Excess capacity continues to keep pressure on the selling prices of merchant formaldehyde. About a quarter of all production enters the merchant market, either directly or as incremental output that remains after captive demands are met. Last year, selling prices fell to about 6 cents per lb, spurred in large part by declines in methanol prices that followed the decline in natural gas prices. Now that gas has become more expensive and a few methanol units have been shut down, methanol prices have increased to about 30 cents per gal, spurring increases in formaldehyde prices.

Demand for formaldehyde has little impact on prices because of overcapacity. The quantity of formaldehyde consumed in adhesives and other components used in construction is small if compared to quantities of other materials. As a result, new home prices have almost no effect on formaldehyde prices.

Well over half of formaldehyde consumption is accounted for by two kinds of resins: urea-formaldehyde and phenol-formaldehyde. The major use of these resins is adhesives for fiberboard, particleboard, and plywood. Growth in demand for formaldehyde in major uses is forecast to average about the same as growth in gross national product (GNP).

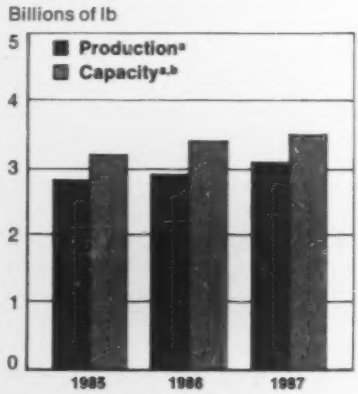
Other uses of formaldehyde are diverse. Many of its derivatives go to industries facing severe import competition, such as textiles. Growth forecasts in these areas are about the same as growth in GNP. Two derivatives, certain polyacetal resins and 1,4-butanediol, accounting for less than 20% of formaldehyde consumption, have growth rates above 5% annually. That is not large enough to cause the total consumption of formaldehyde to rise much above 2% annually in good years.



Phenol

- *Output to increase*
- *Capacity up*
- *Prices higher*

PRODUCTION/CAPACITY



a Synthetic only. b First quarter.

MAJOR PRODUCERS

Allied-Signal, Aristech, Dow Chemical, General Electric, Georgia-Gulf, Shell Chemical

HOW MADE

Peroxidation of cumene (isopropyl benzene) and cleavage to phenol and coproduct acetone

MAJOR DERIVATIVES

Resins (mostly with formaldehyde as comonomer) 40%, bisphenol A 20%, caprolactam 15%

MAJOR END USES

Adhesives 40%, plastics 25%

FOREIGN TRADE

Exports nearing 200 million lb; imports small and holding at about 10 million lb

PRICE

38 to 40 cents per lb, list, after temporary voluntary allowances

The price of phenol will soar this month to 42 cents per lb, stimulated by rises in the cost of raw materials, mostly benzene. In addition, the price increases will be supported by limitations on available capacity to meet rising demand and by future growth in the various uses of phenol.

Output of phenol in 1987 likely will set a record of more than 3 billion lb. If demand for phenolic resins in housing construction continues at its 1986 pace, if exports increase, and if the demand for phenol to make other derivatives rises, then production will total between 3.05 billion and 3.10 billion lb. This would be about 150 million lb more than 1986 production of 2.92 billion lb, according to preliminary estimates of the U.S. International Trade Commission. Previous record production for synthetic phenol was 2.95 billion lb in 1979. Production last year was up more than 100 million lb from 2.78 billion lb in 1985.

Synthetic phenol capacity continues to increase, mainly through debottlenecking programs by nine producers. Several other companies are separating a small quantity of natural phenol—less than 50 million lb per year—from petroleum fractions and coal tar. At the beginning of 1987, synthetic phenol capacity was less than 3.5 billion lb, although some of that capacity may not have been utilized. Based on estimated total production for 1987 and operable capacity available for the year, the average operating rate will be about 90% of nameplate capacity.

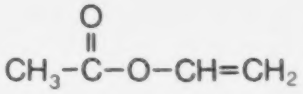
The relatively high operating rate anticipated for phenol plants in 1987 is typical of rates in recent years. Even with the high operating rates, however, phenol prices have been under pressure.

As crude oil prices declined in 1986, the price of benzene, phenol's major raw material, also fell. Phenol prices slipped below 20 cents per lb, even though demand was strong owing to the need for resins, bisphenol A, and nylon 6. Following increasing crude prices early this year, benzene prices increased sharply, with the spot price of benzene about doubling to nearly $1.40 per gal. By March, prices of phenol precursor cumene had increased about 50%, but phenol increased only about 20 to 25%.

Most phenol producers are pushing for substantial price increases. For example, Dow Chemical has raised its contract list price for phenol to 42 cents per lb. Aristech and Shell also have posted similar hikes in list prices. Actual selling prices, now about 30 cents per lb, are expected to go up, but by less than the list price increases, unless benzene tabs continue to rise as a result of more demand for gasoline this summer or because of continued lackluster action in acetone prices.

It is uncertain how substantially increased prices will affect phenol demand and production. Many factors will impinge on production this year. For example, because of the low prices for phenol that producers received in 1986, inventories were drawn down to unusually low levels by year's end. Exports in 1986 increased from 141 million lb to an estimated 180 million lb and are expected to increase further this year. A relatively mild winter has allowed some construction (especially commercial) to move ahead faster than expected, increasing demand for adhesive resins for wood board products as well as for other fabricated phenolic resin products.

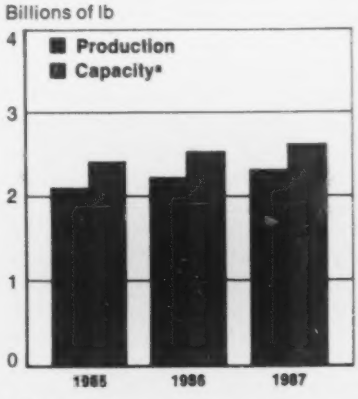
The market for other major-volume phenol derivatives, such as bisphenol A and caprolactam, also could be spurred by construction demand. Much of bisphenol A goes into epoxy and polycarbonate resins, whereas most phenol-based caprolactam goes to nylon 6, the bulk of which, in turn, becomes carpet fibers. These two uses now account for about one third of phenol consumption and are still growing faster than phenolic resins. They continue to be a strong driving force for increased phenol production.



Vinyl Acetate

- *Production growing*
- *Capacity up modestly*
- *Prices rising*

PRODUCTION/CAPACITY



a First quarter.

MAJOR PRODUCERS

Celanese, Du Pont, Union Carbide, USI Chemicals

HOW MADE

Vapor-phase reaction of ethylene, acetic acid, and oxygen

MAJOR DERIVATIVES

Polymers 55%, polyvinyl alcohol 20%, copolymers (mostly with butyraldehyde, ethylene, or vinyl chloride) 20%

MAJOR END USES

Adhesives 35%, paints 30%, paper and textile coatings 25%

FOREIGN TRADE

Exports holding at 600 million to 650 million lb; imports very small, less than 15 million lb

PRICE

About 27 cents per lb

Vinyl acetate needs a major new use to move it out of a slow growth pattern. But none have emerged. Consequently, output this year will increase only about 2%, the same annual rate as during the early 1980s. Some capacity expansion will result from debottlenecking programs. Prices have begun to rise this month.

Some of vinyl acetate's major uses are growing moderately and others are growing a little or not at all. And exports are declining. Some polymers—notably polyvinyl acetate and vinyl acetate-ethylene resins—continue to be the large growth products of vinyl acetate. However, use in these polymers is forecast to increase only 2 to 4% annually for the rest of this decade. Their growth will depend on their use in paints and adhesives. The polymers also find substantial use in products facing strong competition from other materials, tending to dampen their overall growth.

Exports of vinyl acetate for 1987 are forecast to be some 636 million lb, about equal to last year's. Exports in 1986 were up 60 million lb from 1985; they peaked in 1982 at almost 698 million lb.

If global demand for vinyl acetate slows and plant expansion outside the U.S. increases more than expected, this year's forecasts for exports could be too high. But exports likely will be at least 600 million lb. As capacity increases in Asian countries, exports could continue to decline slowly.

A decline in exports would not spur production, but would allow producers to meet, without the cost of major capacity expansions, the slowly growing demand in the U.S. Debottlenecking programs always will add a small amount to capacity, increasing it about the same as growth in production. Such minor capacity gains keep capacity utilization high. For example, production in 1986 increased to 2.25 billion lb, according to preliminary estimates of the U.S. International Trade Commission. Hence, with exports flat or down slightly and with U.S. consumption rising 2%, 1987 output will be about 2.3 billion lb. If output totals 2.3 billion lb, and nameplate capacity for the year averages 2.6 billion lb, the operating rate will be more than 88%, down slightly from the 1986 rate. Production, however, could be limited by a shortage of acetic acid, which is reacted with ethylene and oxygen to make vinyl acetate.

A 2% growth in U.S. vinyl acetate demand, or about 50 million lb this year, will result largely from its use in paints and adhesives, which accounts for more than half of polyvinyl acetate demand (almost entirely as emulsions). That alone is more than one half of vinyl acetate production. Several years ago, interior latex paints led demand growth because they were replacing solvent-based paints. Interior latex paints have completed their takeover and now paint demand growth will depend on housing construction. Housing construction likely will be flat to slightly up in 1987, providing a modest growth for vinyl acetate. Polyvinyl acetate adhesives also go into construction uses as well as many packaging uses where growth now is forecast at about that of gross national product. Paper coating use, at about half of either paints or adhesives, is expected to improve because demand is high for quality printing.

As a vinyl acetate use, polyvinyl alcohol is less than a third of that for polyvinyl acetate. Its largest application is in textile sizes, but no growth is forecast because imports of apparel are increasing.

Among copolymers made with vinyl acetate, use of polyvinyl butyral may be somewhat larger than that of the copolymers made with ethylene. Polyvinyl butyral has one major use—the adhesive film that goes into safety glass for both automotive and architectural markets. No growth is expected in polyvinyl butyral this year because smaller cars are being built and fewer office buildings are being constructed.